REMARKS/ARGUMENTS

The Examiner rejects claims 1-74 under 35 U.S.C.§102(b) as being anticipated by U.S. Patents 4,548,442 or 6,062,650; claims 44-46 under 35 U.S.C.§102(b) as being anticipated by WIPO WO 82/01749; claims 47-52 under 35 U.S.C.§102(b) as being anticipated by U.S. 5,310,249; claims 53-56 under 35 U.S.C.§102(b) as being anticipated by U.S. 5,234,257; and claims 57-59 under 35 U.S.C.§102(b) as being anticipated by U.S. 4,884,847.

Applicant respectfully traverses the rejections for at least the reasons set forth below.

Rejection of Claims 1-38

The Examiner rejects claims 1-38 as being anticipated by U.S. Patents 4,548,442 or 6,062,650. The cited references fail to teach or suggest at least the following italicized features of independent claim 1:

> 1. An excavator, comprising:
> a boom;
> a cutter head, mounted on the boom, for excavating in situ material;
> a body, wherein the boom is mounted on the body;
> a plurality of grippers operable to apply pressure against opposing surfaces of an excavation to hold the body in a selected position and orientation; and
> a control system operable to effect operation of the excavator *both* (a) in a manual mode in which an operator controls operation of the boom and/or cutter head and the plurality of grippers and (b) an automatic mode in which the control system controls operation of the boom and/or cutter head and the plurality of grippers, *wherein the control system comprises a task supervisor, the task supervisor is configured as an engine that invokes at least one of a plurality of state machines to perform a selected unit operation.*

U.S. 4,548,442 is directed to various mobile mining machine configurations. In one configuration, the machine includes a horizontally swinging, wheel-like cutter head mounted on a

crawler and base frame assembly. The cutter head includes a transverse horizontal wheel-like drum on which are multiple peripherally mounted rolling cutter units. To cut hard rock, the wheel-like cutterhead assembly is rotated about its horizontal axis, plunged forward into the hard rock, swept sideward in a first horizontal direction through the hard rock, again plunged forward into the hard rock, and finally swept sideward in the other horizontal direction. The '442 patent teaches manual operation but fails to teach or suggest automatic operation of the mining machine.

U.S. 6,062,650 is directed to a mining machine control system including a first angular encoder for continuously measuring the tilt angle of the boom, a second angular encoder for continuously measuring the angle of rotation of the turret, a linear encoder for continuously measuring linear position of the cutter head, and a controller controlling proportional valves. The valves control flow of hydraulic fluid into a hydraulic cylinder, the speed of rotation of the turret as well as the linear advance of the cutter head. In this manner, the controller continuously controls the boom angular position, the angular position of the turret, and the linear position of the cutting head so as to cut a preselected profile at a predetermined depth of cut and rate of advance. The '650 patent fails to teach or suggest manual operation of the mining machine let alone the use of a task supervisor configured as an engine that invokes at least one of a plurality of state machines to perform a selected unit operation.

The dependent claims provide additional reasons for allowance. For example, the various references fail to teach the use of the task supervisor to set the excavator to continuous boom and single boom sweep states (the '650 patent, at col. 4, lines 14-17, and col. 9, lines 41-45, teaches

away from a single boom sweep state) (claim 4), the use of pressure control and position control functions in hydraulic cylinders (claims 6-7 and 21), the conversion of hydraulic pressure readings into torque (claim 10), the incremental steps of claim 13, an optimization module (claims 17-18), a swing angle optimization module (claim 19), the use of an end of stroke sensor and pressure and/or force sensors to determine whether actuators are or are not locked into position against an excavation surface (claims 20 and 36), roll and pitch automated adjustment algorithm (claims 22-23), the positional sensor of claim 27, the emergency retract line of claim 30, and the predefined fault response state of claims 34-35.

Rejection of Claims 39-43

The Examiner rejects claims 39-43 as being anticipated by U.S. Patents 4,548,442 or 6,062,650. The cited references fail to teach or suggest at least the following italicized features of independent claim 39:

> 39. An excavation method, comprising:
> (a) providing an excavator, the excavator comprising a boom; a cutter head, mounted on the boom, for excavating *in situ* material; and a body, wherein the boom is rotatably mounted on the body and includes first and second swing actuators to effect rotation of the boom; and
> (b) rotating the boom in a first direction through a first angle of rotation, wherein:
> (b1) *when the boom is at a first angle of rotation, the first swing actuator is at the first swing actuator's minimum stroke and the second swing actuator is not at the second swing actuator's minimum or maximum stroke;*
> (b2) *when the boom is at a second angle of rotation different from the first angle, the second swing actuator is at the second swing actuator's minimum stroke and the first swing actuator is not at the first swing actuator's maximum or minimum stroke;*
> (b3) *when the boom is at a third angle of rotation different from the first and second angles, a first longitudinal axis of the first swing actuator*

intersects a second longitudinal axis of the second swing actuator within an angle of rotation of the boom; and

(b4) *when the boom is at a fourth angle of rotation different from the first, second, and third angles, the first longitudinal axis of the first swing actuator intersects the second longitudinal axis of the second swing actuator outside of the angle of rotation of the boom.*

In the excavator configuration of U.S. Patent 4,548,442, the swing cylinders 34a,b (Figs. 1-2) and 528 and 530 (Figs. 6-7)are positioned on either side of the boom 516, which is swept from side-to-side as shown in Figs. 2 and 7. It is not clear from the '442 patent whether requirements (b1) and (b2) are performed by the excavators disclosed by the patent. Moreover, it is evident from the '442 patent that the depicted excavators do not perform requirements (b3) and (b4) as the depicted angle of sweep in Figs. 2 and 7 is too shallow for the longitudinal axis of one swing cylinder to cross over the longitudinal axis of the other swing cylinder both inside and outside of the angle of boom rotation. This relationship is depicted, for example, in Figs. 7-10 of the Specification.

In the excavator configuration of U.S. Patent 6,062,650, the excavator has a boom 12 with a motor driven cutting head 14 and a rotatable turret 20. The boom can be titled on the boom pivot 22 by means of hydraulic cylinders 24 and 26 having pistons 28 and 30. Rotation of the boom is provided by the turret 20 and not by swing cylinders.

The dependent claims provide additional reasons for allowance. For example, dependent claims 42-43 require, when the first swing actuator is at the first angle of rotation, the second

swing actuator is extending or retracting (claim 42) and, when the second swing actuator is at the second angle of rotation, the first swing actuator is the other of extending or retracting (claim 43).

Rejection of Claims 44-46

The Examiner rejects claims 44-46 as being anticipated by WO 82/01749. The cited references fail to teach or suggest at least the following italicized features of independent claim 44:

> 44. A method for operating an excavator, comprising:
> providing an excavator, the excavator including a plurality of hydraulic actuators, a plurality of check valves, a hydraulic fluid supply line in fluid communication with the check valves and the hydraulic actuators, a hydraulic fluid return line in fluid communication with the check valves and the hydraulic actuators, *and an emergency retract line in fluid communication with the check valves*;
> detecting a fault in the hydraulic system;
> closing the check valves in response to the detecting step to maintain at least substantially hydraulic pressure in the hydraulic actuators;
> *pressurizing the check valves with the emergency retract line to open the check valves and effect drainage of the hydraulic fluid from the hydraulic actuators.*

The system of WO 82/01749 is directed to a hydraulic fault protection system using a check valve to hold a load in position. The system has a main control valve 15 provided with a load check valve 42 and a vent valve 90. The load check valve 42 permits free flow of fluid from the control valve 15 toward the load supporting chamber 5 of the system and blocks fluid flow from the load supporting chamber 5 towards the control valve 42. The vent valve 90 permits the load check valve 42 to be opened by fluid pressure from the load supporting chamber 5 to allow fluid flow through the hose connection 22 and control valve 15 to drain 10. A

cancelling valve 34 is added to the system to override the vent valve 90 upon failure of the hose connection 22 and reblock fluid flow from the load supporting chamber 5 towards the hose connection 22 and control valve 15. The load may be selectively released by an operator by manipulating a control to open the vent valve 90, thereby draining a chamber of the load check valve 42. A cancelling valve 34 can be used by the operator to stop lowering of the load by manipulating the control.

The present invention differs in that the check valve is pressurized by an emergency retract line to open the check valve. In contrast, the system of WO 82/01749 *depressurizes* the check valve to release the load.

The dependent claims provide additional reasons for allowance. For example, dependent claim 45 requires, in the pressurizing step, a corresponding pressure applied to each check valve to be sufficient to overcome a respective hydraulic pressure exerted against the check valve by the corresponding hydraulic actuator.

Rejection of Claims 47-52

The Examiner rejects claims 47-52 as being anticipated by U.S. Patent 5,310,249. The cited references fail to teach or suggest at least the following italicized features of independent claim 47:

> 47. A method for operating an excavator, comprising:
> providing an excavator, the excavator comprising a body, a cutter head, and a plurality of hydraulic actuators;
> *setting at least one hydraulic fluid-containing cavity in each of a first set of the hydraulic actuators to a pressure control function in which a pressure in the cavity is controlled*; and

setting at least one hydraulic fluid-containing cavity in each of a second set of the hydraulic actuators to a position control function in which a position of the corresponding actuator is controlled.

U.S. 5.310,249 is directed to an apparatus for automatically controlling one or more of cutter penetration depth, cutter penetration rate and cutter slew rate. A sensor is used for sensing a given mining machine parameter. The parameter can be swing cylinder length, cylinder extension, boom pivot pin strain (or boom force), boom swing cylinder strain (or swing cylinder force), swing cylinder hydraulic pressure, and cutter head drive motor current. A controller processes the given mining machine parameters to provide one or more of an optimum cutter penetration depth, cutter penetration rate, or cutter slow rate value and controls one or more of these variables. The '249 patent does not disclose the use of pressure and/or position control functions.

The dependent claims provide additional reasons for allowance. For example, dependent claim 48 is directed to a gripper comprising first and second hydraulic actuators and wherein at least a first cavity in the first hydraulic actuator is set to the pressure control function and at least a second cavity in the second hydraulic actuator is set to the position control function. Dependent claim 49 is directed to a first hydraulic actuator comprising first and second cavities for receiving hydraulic fluid and wherein the first cavity is set to the pressure control function and the second cavity is set to the position control function. Dependent claim 50 is directed to the first and second sets of hydraulic actuators being at least partially overlapping. Dependent claim 51 is directed to the further step of setting at least one cavity in at least one of the hydraulic actuators

to a differential position control function. Dependent claim 52 is directed to the further step of setting at least one cavity in at least one of the hydraulic actuators to a cooperating position/pressure control function.

Rejection of Claims 53-56

The Examiner rejects claims 53-56 as being anticipated by U.S. 5,234,257. The cited references fail to teach or suggest at least the following italicized features of independent claim 53:

> 53. A method for realizing a desired pitch and roll in an excavator, comprising:
> providing an excavator, the excavator comprising a plurality of grippers operable to exert pressure on opposing surfaces of an excavation to maintain a desired position and orientation of the excavator; and
> *receiving an attitude command containing desired settings for pitch and roll;* and
> *converting the attitude command into separate actuator control commands for each of the plurality of grippers.*

U.S. 5,234,257 is directed to a mobile mining machine having a wheel-like cutter head assembly supported by a pitch boom assembly that causes movement of the cutter head assembly in the vertical plane. A swing boom assembly supports the pitch boom assembly and is supported by the main frame of the mobile mining machine. The swing boom assembly has a pivot axis that is tilted from vertical and swings the cutter head and the pitch boom during mining to cut a tunnel having a wide, flat floor. Thrust is provided by thrust cylinders located between gripper shoes and a main beam. The '257 patent fails to disclose an automated method for converting pitch and roll commands from the operator to actuator control commands for each gripper.

The dependent claims provide additional reasons for allowance. For example, dependent claim 55 is directed to the further steps of:

converting the position feedback signals into pitch and roll values;

comparing the pitch and roll values with the pitch and roll values in the attitude command; and

determining an error vector, the error vector comprises an adjustment for roll and an adjustment for pitch. Moreover, the precise steps of dependent claims 55-56 are absent from the reference.

Dependent claim 56 is directed to the further step of:

converting the adjustment for roll and adjustment for pitch into actuator control commands.

Rejection of Claims 57-59

The Examiner rejects claims 57-59 as being anticipated by U.S. 4,884,847. The cited references fail to teach or suggest at least the following italicized features of independent claim 57:

> 57. An automated method for excavating *in situ* material, comprising:
> providing an excavator, the excavator comprising a body , a boom, and a cutter head, *wherein the excavator comprises a memory storing a profile of an excavation face*;
> the cutter head removing material from the face;
> *determining a revised profile of the excavation face after the removing step*; and
> *updating the profile of the excavation face stored in the memory.*

U.S. 4,884,847 is directed to a method for mapping mine excavation or tunnel entry conditions by mounting an array of sensors on a vehicle. Some of the sensors provide knowledge of the vehicle location in the entry and others provide knowledge of entry conditions. By interpreting data collected from the sensors, a map can be generated of the entry strata for a given vehicle location in the entry. The map can be compared with similarly generated maps to indicate changes in the entry condition. The '847 patent fails to teach or suggest the maintenance of a map of the excavation face profile periodically during removal of material from the face to assist automated position control of the cutter head.

The dependent claims provide additional reasons for allowance. For example, dependent claim 58 requires the profile to be a plan view of the excavation face. Dependent claim 59 requires the profile to be a cross-sectional view side view of the excavation face at a plurality of selected points along the face.

Rejection of Claims 60-64

The Examiner rejects claims 60-64 as being anticipated by U.S. Patents 4,548,442 or 6,062,650. The cited references fail to teach or suggest at least the following italicized features of independent claim 60:

> 60. An excavator, comprising:
> a boom;
> a cutter head, mounted on the boom, for excavating in situ material;
> a body;
> a plurality of grippers operable to apply pressure against opposing surfaces of an excavation to hold the body in a selected position and orientation; and
> *an optimization module operable to monitor a selected excavation parameter and effect a change in the operation of the cutter head when the*

monitored selected excavation parameter one of exceeds or falls below a predetermined threshold, wherein the selected excavation parameter is at least one of:

(i) a grade of a material removed during cutter head operation;

and

(ii) a quantity of material removed during cutter head operation.

U.S. Patent 4,548,442 does not teach or suggest an optimization module.

U.S. Patent 6,062,650 is directed to a continuous, closed loop Proportional Integral Derivative or PID positional system whereby set-points ("should-be" values of boom-angle, turret-angle, and linear sump position) are continuously generated by a computer typically in the order of ten to twenty times per second. Actual positional information on each of boom-angle, turret-angle and linear sump position is usually received at a frequency greater than a set-point generation frequency. The difference between actual and "should-be" values is continuously reacted to by the computing capability and by specifically chosen hydraulic drives, valves and pumps with the constant aim of driving that difference (error) to zero. Moreover, the various pressures (P_1 - P_6) may be programmed to operate within predetermined limits and if, for example, these limits are exceeded in one or more instances, the computer will adjust some other function, e.g., reduce the rate of advance, in order that the predetermined limits will be reinstated.

The dependent claims provide additional reasons for allowance.

Rejection of Claim 65

The Examiner rejects claim 65 as being anticipated by U.S. Patents 4,548,442 or 6,062,650. The cited references fail to teach or suggest at least the following italicized features of independent claim 65:

65. A method for excavating *in situ* material, comprising:

providing an excavator, the excavator having a rotatable boom and a cutter head mounted on the boom for excavating the *in situ* material by rotating the boom back and forth across an excavation face while the cutter head is in contact with the excavation face for at least a portion of each boom rotation; and

automatically reversing a direction of rotation of the boom when a swing cycle optimization module detects that the cutter head is no longer in contact with the excavation face, wherein the swing cycle optimization module automatically reverses the direction of boom rotation when at least one of a hydraulic pressure measured in at least one thrust actuator and the swing torque drops below a predetermined threshold.

U.S. Patent 4,548,442 does not teach or disclose an automated system for reversing the direction of boom rotation.

The '650 patent, at col. 9, lines 46-52, teaches that if pressure set points are *exceeded* the computer will adjust some other function, such as reduce the rate of advance, to reinstate the selected set points.

Rejection of Claims 67-74

The Examiner rejects claims 67-74 as being anticipated by U.S. Patents 4,548,442 or 6,062,650. The cited references fail to teach or suggest at least the following italicized features of independent claim 67:

67. A method for controlling thrust pressure, comprising:

providing an excavator, the excavator comprising at least one thrust actuator for forcibly engaging a cutter head with an excavation face, the cutter head being mounted on a boom and comprising one or more excavating devices and the at least one thrust actuator operatively engaging at least one variable orifice valve for supplying hydraulic fluid to the at least one thrust actuator;

monitoring a parameter that is at least one of (a) a thrust force applied on the cutter head by the at least one thrust actuator, (b) a force on a cutter; (c) a speed at which the boom is rotating, and (d) a swing torque by the boom;

when the parameter exceeds a selected threshold, opening the at least one variable orifice valve a selected amount to relieve the pressure in the at least one thrust actuator, *wherein the selected amount is a function of at least one of the following:*

(i) the amount by which the cutter force exceeds a selected value;
(ii) the speed at which the cutter force is increasing;
(iii) an amount of time that the selected value has been exceeded;
(iv) the amount by which the difference between a commanded boom rotational speed and an actual boom rotational speed exceeds a selected value;
(v) the speed at which the speed difference is increasing;
(vi) the amount by which the swing torque exceeds a selected value; and
(v) the speed at which the swing torque is increasing.

U.S. Patent 4,548,442 does not teach or suggest an automated control system.

U.S. Patent 6,062,650 is directed to an automated control system. The control of the cutting head 14 is implemented using: a first angular encoder 40 at the bottom of the boom pivot 22 to continuously measure the tilt angle of the boom 12; a second angular encoder 44 at the end of the shaft 45 to continuously measure the rotating angle of the turret 20; a linear encoder 55 to continuously measure the linear position of the housing 42 and the cutting head 14; pressure transducers P_1 and P_2 to continuously measure the pressure at each end of the hydraulic drives 41 and 43; pressure transducers P_3 and P_4 to continuously measure the pressure at each end of sumping cylinders 62 and 64; and power transducer 57 to measure the power input to motor 18 which drives the head 14. Additionally, the speed of rotation of the cutting head 14 is controlled through variable speed drive 74, boom vibration and/or frequency can be measured and controlled by accelerometer 80, tool temperature may be measured and controlled by thermocouples, and tool force may be measured and controlled using strain gauges.

The dependent claims provide additional reasons for allowance. For example, the dependent claims require each of the claimed options to be present in a respective claimed configuration.

Applicant wishes to clarify the intended meaning of certain claim language in light of the Federal Circuit decision "SuperGuide Corporation v. DirecTV Enterprises, Inc., et al., 358 F.3d 870 (Fed. Cir. 2004). In that decision, the Federal Circuit held, under the unique facts of that case, that the phrase "at least one of a desired program start time, a desired program end time, a desired program service, and a desired program type" means "at least one of a desired program start time, at least one of a desired program end time, at least one of a desired program service, and at least one of a desired program type".

Applicant has used the phrases "at least one of . . . and" and "and/or" in a number of claims and wishes to clarify to the Examiner the proper construction of this phrase. Applicant intended the phrases "at least one . . and" and "and/or" as used in the claims to be an open-ended expression that is both conjunctive and disjunctive in operation. For example, the expressions "at least one of A, B and C" and "A, B, and/or C" mean A alone, B alone, C alone, A and B together, A and C together, B and C together, and A, B and C together. Applicant believes that this construction is consistent with the Examiner's construction of the claims in the Office Action. If the Examiner disagrees with this construction, Applicant respectfully requests that the Examiner notify Applicant accordingly so that Applicant can further amend the claims.

Based upon the foregoing, Applicants believe that all pending claims are in condition for allowance and such disposition is respectfully requested. In the event that a telephone conversation would further prosecution and/or expedite allowance, the Examiner is invited to contact the undersigned.

Respectfully submitted,

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